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QUESTION BOX

Question 1: Do water meters increase or decrease cost of water supply to consumers?

MR. A. A. REIMER: We have taken the actual records of several hundred cases from our old flat rate system, and compared them with the same places under the meter system. We find that 71 or 72 per cent who go from flat rate to meter rate save money. On our side of the ledger we make that up from the other 28 or 29 per cent; so that we break even as a department; but over 70 per cent of the people actually save over the old flat rate.

MR. H. P. BOHMANN: When our flat rate was in force the owner of an eight room residence with modern plumbing paid about $15 annually. Under our metered rate the assessment is between $3 and $5 annually.

MR. J. N. CHESTER: In two or three plants where we have made investigation along this line the results have been that changing hotels, saloons and large consumers from flat to meter rates increased the cost of water to them. Another feature we worked out was that those families who had servants in the house generally paid more than those who handled their own spigots, and therefore believe that it depends largely upon the consumers. A community of working men's houses, unless your meter rates are minimum, or extremely high, cut down their water rent by putting on meters.

On the other hand in palatial residences, or even medium class ones, where they have servants in the house who are careless, and also fail to report leaky plumbing, etc., the consumer is going to pay more for the water metered.

MR. CHARLES F. BARRETT: In Salt Lake we gathered data as to some 285 domestic meters during the year 1913 and we found a saving of approximately 35 per cent. On a lot of saloons, rooming houses and apartment houses we found an increase on an average of approximately 20 per cent. On a number of industrial concerns we found the average rental very much higher and increasing.

MR. WIRT J. WILLS: As to whether the installation of meters decreases the price to consumers might be indicated from the fact that the people voluntarily asked for 8000 meters in the last four years. Up to recently we had no right to put a meter on unless the consumer asked for it. Most people have had experience with gas, electric and other kinds of meters, and are naturally prejudiced against meters; but after the 8000 had them in and got to talking around to their friends we have put in 2000 a year, the consumers voluntarily asking for them. The cost of that installation is charged up to construction of the plant. The benefit to the water plant is through the consciousness of knowing that most of the water is being paid for. There have been times in our life when we wanted to reduce the waste as much as possible. With this installation of 16,000 meters we now have a total of 25,000, and with the rigid inspection that we now employ we are furnishing per capita about 90 to 95 gallons per day, and are not pumping the same amount of water that we did ten years ago when the city was some 40,000 less than now in population. Metering has reduced the consumption probably 4 million gallons per day.

MR. E. E. DAVIS: There is only one answer to this question. Increasing the number of meters ought of course to decrease consumption. There is no question about that and it ought to decrease cost. When you decrease waste it certainly ought to follow that the cost is decreased.

Question 2: How is the cost of installation and maintenance of meters borne?

MR. E. E. DAVIS: Our meters are installed and maintained by the city.

MR. CHARLES F. BARRETT: The cost of installation is borne by the consumer at Salt Lake City.

MR. W. J. WILLS: We charge the installation to construction.

MR. J. N. CHESTER: The Public Service Commissions are putting the cost on the water companies or water departments.

MR. H. P. BOHMANN: By consumers. Although of the opinion that the principle is wrong, after the installation of nearly 60,000 meters, the speaker is afraid it is too late to make a change. If installed by Water Department fewer types and only the better ones would be installed.

MR. THOMAS HODKINSON: In Canada the municipalities are bearing the cost; and in our city the cost of installing a five-eighth inch meter is from $1.50 to $1.75 plus cost of meter. In case we put in an outside meter box it ought to be charged to the consumer according to the law, but that part of the law is a dead letter, and we bear the cost of the installation and maintenance, which is paid for out of revenue. The people at the present time are asking for meters. We charge 50 cents per quarter meter rent, with a minimum charge of 15 cents per 100 cubic feet. We give a 40 per cent discount for prompt payment. No discount is allowed off meter rent.

MR. C. W. WILES: From investigation of a large number in our vicinity we find that taking a flat rate on a house fully equipped it will run about $16 a year. The average by meter will run about $11 to $13; but we think that we save enough water to more than make up the difference in expense. As to the ownership of the meters the department should furnish the meters. It is a question whether they should charge rental to the consumer. That is optional; but in some places the department furnishes the meter and charges a rate sufficient to cover the cost and maintenance of the meter. The department should not maintain meters against frost or freezing; the consumer should pay the cost of that, because it is often due to his neglect that a meter freezes. The department should furnish the meters, and should charge a small amount, which should be

nominal, to maintain them in good repair. The ordinary domestic consumer will save over a $16 or $18 flat rate $4 or $5 every year by the use of meters, and on the other hand the department will save in consumption and wasted water.

MR. GEORGE F. COOPER: Will the gentleman please state what his meter rate is?

MR. C. W. WILES: Our rate is equal to 25 cents per 1000 gallons, but we abandoned the use of the term gallons some years ago and we now figure by cubic feet which saves us millions of figures in calculating. We charge 25 cents per 100 cubic feet less 10 per cent as an inducement to prompt payment, which is equivalent to 25 cents per 1000 gallons.

MR. C. FALLER: We sell water meters at their absolute cost to us. The minimum meter rate in certain classes of houses is so much lower than the flat rate for those houses that in the last two years the revenue derived from our water service has not been increased although there have been large extensions of water service.

Does not the answer to this question depend upon the relation the flat rate bears to the meter rate? One must know the schedule in each case; also the rules and regulations, and the class and habits of the consumers. No valuable conclusion can be reached unless the controlling conditions are set out. To answer the question abruptly as it is asked would not satisfy, since it would merely show a fact quite unrelated to other facts and conditions.

MR. H. HYMMEN: We furnish the meters. The consumer pays the plumber for installing them. Our rate is $1.13 a quarter net per 1000 feet. For excess over 1000 feet at the rate of 18 cents per 1000 gallons. There is a sliding scale running down to 6 cents per 1000 gallons, if they use over 10,000 gallons a day.

MR. H. C. HODGKINS: In the city of Syracuse they have reduced the meter rate to 12 cents per 100 cubic feet. The consumer pays for the meter. The department makes the repairs to the meters and charges the cost to the consumer. It ought to be self evident that the consumer will save by purchasing water at meter rates; but there is one other saving which the speaker can give to you in a nut shell.

The conduit line at the time of the first construction cost $1,000,000. Fifteen years following the installation of the first conduit a second one had to be built, at the cost of say another million dollars. These figures are not exact, but they are sufficient for the illustration. It is estimated that in 1925 an additional conduit or additional supply will be necessary. Four per cent on $1,000,000 means $40,000 a year saved to the tax payers; so that while the consumer saves from his water payment, the city budget is also saving a larger item in interest charges per year every year that another conduit is postponed due to the saving of water through meters.

MR. CHESTER R. MCFARLAND: We have both a flat rate and a meter rate. Under our contract we have an arrangement, or have a provision in the contract, whereby, if the consumer is dissatisfied with the flat rate, he can secure the meter rate by installing and maintaining the meter; or if we are dissatisfied with his consumption on the flat rate, we can install a meter at our cost and maintain it, and put him on meter rate. The result has been that although the people were dissatisfied for a number of years with the flat rates that were then established, we encouraged them to put on meters, and the introduction of the meters has had the result that instead of the criticism of the rates that obtained before, we are now receiving the commendation of the public because they are getting water for less than they got it before. It is proper that the flat rate should be much higher in proportion than the meter rate, because a man that takes water on an annual contract flat rate is going to waste it, whereas the man who takes it by meter is going to take care of his fixtures and reduce his consumption. We have found that where a man installed a meter it was very bad practice to have him take care of that meter and see that it was in proper working order, so that we have assumed the care of meters. The consumer pays for the first installation, and after that we pay all repairs, and if the meter for any reason wears out or becomes useless we install another meter at our cost. The consumer pays for one installation only. We are today operating about 1800 meters. We find the result very satisfactory. Our revenue is falling off in most cases where meters have been installed; but the falling off in revenue has been amply compensated by the saving in the cost of additional construction and in the consumption of water. We pump from wells and the securing of this water is expensive, so that we think it wise to keep down the

consumption and be paid for actually what we are serving. Our rate is 17 cents per 100 cubic feet. We do not use the term gallons because of the trouble in computing quantities; therefore we are using cubic feet as a basis, and 17 cents per 100 cubic feet is the maximum charge with a discount of 10 per cent. The first 5000 feet consumed in a month is charged at 17 cents; the second 5000 feet at 15 cents, and so on down to 9 cents for the large consumers. We have found that this is working very satisfactorily and that while our revenue is falling off in some cases, yet taken as a whole it is building up. Our consumption is only about 60 gallons per day per capita.

MR. W. C. HAWLEY: Mr. Hodgkins has hit the nail on the head. It is not a question merely of what the consumer saves on his water bill, but rather as to what is saved in the way of additional investment in the plant and in fixed charges on that investment. At Atlantic City some years ago the consumption per capita was from 250 to 260 gallons. After meters had been installed two years this consumption was cut down to 50 or 60 gallons per capita. We postponed an investment of more than a quarter of a million dollars for a number of years, and the saving in coal alone at the pumping station more than paid the cost of installing the meters. At the plant with which the speaker is now connected we are furnishing a large population just inside and outside of the city of Pittsburgh. We are on a meter basis exclusively or practically so. Our consumers are paying less at the rate of 20 cents per 100 cubic feet than the people in the balance of Pittsburgh who have corresponding properties are paying on a flat rate. Pittsburgh has a nominal rate of 18 cents per 1000 gallons or $13\frac{1}{2}$ cents per 100 cubic feet, but is selling water to less than 10 per cent of its domestic customers by meter. In this case the meter rate is, doubtless, too low for the cost of the service, but when the city does go on to a meter basis, as it must in the not distant future, and has increased its meter rate to a reasonable figure, the great majority of those now paying on the flat rate basis will save money, and the reduction in waste will materially reduce the expense of operating the city's plant besides deferring large investment for increase in plant. This is a concrete illustration of the saving to be effected by the introduction of meters, and, as shown, the saving is not alone in the reduction of water bills but a material part is in the saving of investment which would be necessary if it were not for the meters.

MR. E. E. PARKER: We supply a meter for every service. We make two charges on our supplies; the first charge being a capacity charge, or the charge which we will make whether we furnish any water or not; the second charge is the output charge, or the cost of supplying the water used. The first charge on a five-eighth inch meter is $1.50 for six months. It represents the cost of maintaining the service, interest on investment, cost of reading meters, etc. The second charge is 6 cents per 100 cubic feet, and represents the actual cost of supplying the water.

MR. J. DAVIS BARNET: The speaker's experience coincides with that of a previous speaker (Mr. Hawley), that is, with an increasing number of domestic consumers the use of the meters has lessened the total daily pumpage. As the water works carries the whole cost of the equipment, it has it within its control as to what to buy and what to put into the house; and the speaker's railway experience having impressed upon him the value of uniformity of parts, he can say that since he has been on the Commission we have purchased but one type of meter. No consumer comes to us and says that the other fellow's meter is more honest than ours. We keep the very smallest number of parts for renewals, and it permits us to make changes and repairs very quickly.

MR. PATRICK GEAR: We do not have to pump water in Holyoke and we have comparatively few meters there; probably that is the reason we have adopted a flat rate for selling water. We sell metered water at a flat rate of 5⅓ cents per 1000 gallons, whether the consumer uses 1000 or 100,000 gallons. It will be hard to educate our people to a meter rate, because they have today in storage about 55,000 gallons for every man, woman and child in Holyoke, enough to supply us if we do not get any rain for a year. Our consumption is 105 or 106 gallons per day per capita. We furnish a meter on request to any building that contains four or more families. Our flat rate today is $6 a year per family and there is no limit to the number of fixtures. We charge $5 for each family per year for the metered water used, whether it is 5 gallons per capita or 10 gallons, up to 2,500 cubic feet of water every month per family. Anything over that will be charged for under the meter rate. We put the meter in and care for it ourselves. From the speaker's experience with meters he does not believe that if any man should come along and say,

"Here is a meter for $8, here is one for $12," that he would take the $8 one, because if you buy a good meter you are going to get the value of your money. We take care of the meters ourselves, repair them, test them, and keep them in order, and we charge for the meter 12 per cent of its cost for reading and care. The people who put in meters in tenement districts rather than paying by fixture rates are saving money in their bills anywhere from $10 to $15 a year if they take care of them.

MR. ROBERT ELLIOTT: We have something like 18,000 services, of which something over 15,000 are metered. We furnish the meter free and install it. We do not install services. We keep the meter in repair without cost to the consumer. We have reduced our pumpage something like 15 per cent in the last five years, and increased our revenues 25 to 30 per cent.

MR. OSCAR BULKELEY: Since 1910 Rockford, Illinois, has reduced the consumption per capita from something over 100 gallons, to 57 gallons last year. During that time every service has been metered. The actual saving to the people in their water bills has largely been concealed because of the fact that the flat rates and meter rates have quite generally been very unequitable. The saving effected by the meter would be very evident if our water rates, past and present, were based upon the true cost of service.

HENRY P. BOHMANN: Within the past year we succeeded in weeding out the last 1000 unmetered consumers. This was done for the benefit of the consumer who derives a direct benefit by reason of the reduction of the water bill and it is also to the advantage of the plumbers to put the plumbing of these people in first class shape; and it has had a very remarkable effect in the reduction of our pumpage. For five years prior to 1913 we had an average daily increase over the previous year of from 3 million to $6\frac{1}{2}$ million gallons a day. This was cut down to 370,000 gallons daily average last year, and the increase in our revenue per million gallons pumped was $3.08. In other words, in 1913 we received $53,000 more for the same amount of water as compared with 1912. This shows that the general installation of meters is for the benefit of the consumer as well as the water company or department. Our rate is $4\frac{1}{2}$ cents per 100 cubic feet. We have no minimum or service charge. We have 50,000 con-

sumers that do not pay more than $5 a year; 13,000 that pay $2 a year. This is only made possible from the fact that we have 100 large consumers that pay 50 per cent of the entire assessment; otherwise we could not afford to furnish water at the low rate. We have some that do not pay more than 50 cents a year. The speaker would recommend a minimum rate; still the people in the city of Milwaukee have been taught that the small consumer has the same rights and should get the same rates as the man that makes beer out of it.

MR. LOUIS L. TRIBUS: Until the last speaker named his 50 cents a year rate, the speaker did not suppose any citizen in the United States had the advantage over a small company in the west—which will not be named—in which the speaker has been interested for some years. Out of pure generosity of heart the company, a few years ago, allowed the people to put in meters at their own expense. Looking over some of the meter bills recently it was found that they have come down in some cases to as low as 19 cents per quarter. We shall soon have to go to the Public Utilities Commission of the State to ask the privilege of establishing a minimum rate; and we are going to put in meters.

MR. G. SHOEMAKER: At Waterloo we have 4600 consumers, 4500 being metered. The meter rate is 25 cents per hundred cubic feet. On the old flat rate the average bill was $15 a year. Of a list of 1917 consumers, who were changed from flat rate to meters, the rates of 97 remained the same, 1106 rates were reduced an average of $3.43 each per year; 714 rates were increased an average of $4.80 each per year, making a total decrease for the 1106 consumers of $3800.68, and a total increase for the 714 consumers of $3429.39; or a total loss on 1917 meters of 19.4 cents each per annum. In 1910, we had 3100 consumers, and our pumpage was 526,000,000 gallons per annum. In 1913 we had 4600 consumers and the pumpage was 490,000,000 gallons. The gentleman who just spoke, referred to a meter bill of 19 cents per quarter. An old book at Waterloo, containing accounts prior to 1904, shows that bills were collected at one and two cents per month.

MR. JERRY O'SHAUGHNESSY: Would like to say a word in regard to meters, and, of course, incidentally, advertise the progressiveness of Columbus, Ohio.

Years ago, we could scarcely pump the water as fast as the consumers used it. To overcome this strain on the pumps and to stop a considerable wastage of water that we knew existed, an arbitrary rule was made which increased the flat rate, on which basis the water rents were paid, 100 per cent. The people could take their choice of paying this amount or, by installing a meter, receive water at the rate of 6 cents per 1000 gallons with a ten per cent discount for prompt payment. The water delivered at that time was a filthy commodity to say the least; it seemed hardly fair to take the money for it. It should have been measured by the bushel rather than by the gallon. Later this condition was changed by the erection of a storage dam and treatment of the water by filtering and softening. It is not as easy for us to get good water as it is in the home of my friend from Holyoke. God has not favored us with pure water but makes it dependent upon us, with mechanical means, to procure it. However, the people took kindly to the change and put in meters. They did this too at their own expense. The speaker does not believe that this is the correct way to put in a meter system as he thinks the city should own the meters, but circumstances were such that we were compelled to do it at that time, and as a consequence, we have continued to sell the meters to the consumers. While the meter belongs to the consumer, the department maintains it without charge, except in the case of water freezing in it or its derangement having been caused by the carelessness of the owner.

We have over 30,000 active accounts in the water department and 93.3 per cent of the services are metered. In 1901, the superintendent of the water department reported that 21,000,000 gallons of water per day was being pumped. According to the 1900 census, Columbus had 126,000 people. In 1910, it had 182,000. For 1913, with the same ratio of increased pumpage, 17,500,000 gallons was reported as against the 1900 report of 21,000,000 gallons.

Columbus could not go back to the old way of selling water on the flat rate. If it did, we simply would have to impound more water and make provision, at an enormous expense, to meet the increased demand. The speaker really cannot see any side to this question but the meter side and he does not think anybody can conscientiously defend the flat rate system. Even if it is a place like Syracuse or Holyoke, with plenty of water, it is still an expense to get and deliver it.

MR. E. E. DAVIS: No city in the United States has experimented to any greater extent than Richmond, Virginia. We have the fourth water works that was ever built in the country; and, when it comes to the meter system the speaker does not see how any town can ever think of selling water by the old flat rate. Everybody was at first opposed to meters, because they said people would not use water enough to keep their premises clean, and that the question of saving waste was simply imagination on the part of the head of the water department. On one occasion, to test it, four houses were supplied from a one inch tap under 80 pounds pressure. Those four houses paid $11.89 every three months for water. Our rate was at that time 15 cents per 1000 gallons, with no scale. To demonstrate that something was going on the inspectors were not allowed on these premises for eighteen months, but in riding by in the car one could see water being used. A first-class meter was put on that tap to demonstrate to our city council that they were the people that were mistaken and not the water works people. The meter was started at three o'clock on the thirty-first day of July. On the thirty-first day of August, the meter showed that those four houses had used 456,000 gallons of water in just thirty-one days. The flat rates they were paying at that time were $3.38, $2.38, $2.88 and $3.25 per quarter. We have not had excess bills over half a dozen times in three years for either one of those houses. They are all getting water now for $2 for three months and using 13,500 gallons.

When we started allowing the people to purchase their meters and charging 25 cents per 1000 gallons for water, Mr. Green of the Southern Road said, "We cannot pay you 25 cents per 1000 gallons; we are only paying $100 per year for each locomotive running." I said, "How much approximately do they hold and how many times do you fill up your tenders?" He told me. I said, "Figure that up into the year and let me install a meter there for you and see what the difference is." That was at the 25 cents per 1000 gallons rate, a pretty high rate. So we figured it up and found that each one of his tenders used 2000 gallons. Some time after that we reduced the rate to 15 cents, and then his bill came down.

But the most important thing connected with meters is this abominable question of waste. They are kind enough at home to have confidence in the head of their department and let it be discretionary with him as to where meters ought to be put. A meter was put in

a saloon, and allowed to stay there for twelve months; the first month the bill was $5; the next quarter the bill was $2.50. At the start we made a meter charge of $2 a year. The courts decided that we had no business to charge rent for city property, so we abandoned that charge but we allowed the people to purchase the meters, paying 15 cents per 1000 gallons for all the water they used. It cost the city on the ordinary dwelling house with its necessary fixtures for the use of the premises, taking everything into consideration $6.35 a year to supply water into the tap. Then we made a minimum rate of $8 a year, which is $2 a quarter. We put a meter at a shoemaker shop and at the rate charged, being no minimum rate at that time, he paid $1.68 a year for his water. It was costing us $6.35 per year to maintain this supply. We had another case on the hill where a man found out he could let a stream the size of a straw run constantly into a barrel without the meter registering, and about every six months he paid us 68 cents. The fact was demonstrated that something had to be done. Then the Board of Health people began to come after us and said, "You should not introduce meters, because the people will not use enough water to keep their premises clean." Then we took up the question of a minimum rate, and introduced a minimum rate of $8 a year, which is in effect now. For larger places like hotels or other large consumers we do not add that minimum rate of $2 per quarter, but if such a consumer shuts down his plant and does not use any water we do not let him have it at any less than $2 per quarter. Several manufacturing plants had made connections without any evil intent, just to steal a little water. One man had a four-inch fire service besides his house connection. He had a meter on the other connection but he said he was getting his water for his boilers from a well. Another man dug a well 100 yards below him, and he reported his well was not giving the quantity of water it had. It occurred to me that if those wells were pretty close up the other fellow's must be suffering too. He had a connection to wash out his well every Saturday. On inspection we found that the well had been dry for the last six months. The owner said that he thought that the concern was paying for what water it got and he tapped the fire line. We sent him a bill for $338 and asked the firm to buy the meter.

Question No. 3: Experience with lead or tin lined iron pipe; comparative efficiency, life and cost?

MR. P. GEAR: At the meeting of the New England Water Works Association held in March last, a gentleman from Boston made the suggestion that you could clean out all services of iron pipe with a hand pump, by going into the cellar, disconnecting the pipe there, making a little ball of tissue paper, and forcing it through the pipe. The speaker tried that method when he got home, and found that it did clean out services that were in pretty bad condition; and he also tried the method on five or six services that were anywhere from 35 to 40 feet long, and found that it worked all right, except on services which were in very bad condition. Those it was tried on were old galvanized iron pipe. You would hardly think that anybody could do it, but it can be done. It will work in an elbow of 45 degrees. It will go through lead pipe, or any other kind of pipe, if you give it time. A pail put under the services would take about three or four minutes to fill, which would be filled after the services were cleaned in six or seven seconds. It is very handy for cleaning out services in paved streets where you do not want to take them up. A man whose house stands back 30 or 40 feet from the street will be delighted to find that you can make such a great improvement in the condition of the service pipes without being compelled to dig up the lawn. Open it up inside of the wall line and attach your pump there. If the full results are not obtained the first time of making the trial try it again. After you run up to 50 or 60 pounds pressure you can drop off and relieve it some. If you were to run up to 250 pounds, you would be liable to break the pipe. When the normal pressure was 75 pounds the speaker has run the gauge up to 150 pounds, giving it time to make itself smaller and go through. There is another machine gotten up by a man in Massachusetts, who takes a drill and sets it up in the cellar in order to clean out the service, making it as good as ever. He has rods connected 100 feet long. That, however, will not go around any bend.

SECRETARY DIVEN: Are the rods not flexible?

MR. P. GEAR: Yes, but you are liable to get stuck and leave part of the rod in the pipe. If it is a straight run from the cellar out to the main, you could go straight through, and clean your services out so that they will be as good as the day they were put in.

SECRETARY DIVEN: You can relieve the pressure on the force pump by opening a nearby fire hydrant to give relief, doing away with the

back pressure. This has been done where we could not clean the pipe out with the pump otherwise.

MR. CHARLES S. POTTER: In Louisville, instead of using the method as suggested, we uncouple at the ferrule and insert rye bread then connect and open ferrule, also faucet in kitchen, we carry 65 to 75 pounds pressure and find it sufficient to quickly and thoroughly clean any lead service pipe.

Before making renewals or enlargements, on complaint by consumer of lack of pressure, we use this method, and in many cases are able to save cost of new service.

PRESIDENT THOMAS: Do you force that through under pressure?

MR. CHARLES S. POTTER: Yes, frequently we find the people ask to have services enlarged when if the services were cleaned no enlargement would be necessary.

PRESIDENT THOMAS: Mr. Gear says that with the method described by him they do not have to take up the pavement.

Question No. 4: What is the best method of making temporary repairs to pavements torn up for water works construction or repairs, putting in services, etc?

MR. H. P. BOHMANN: If the ditch is dry and earth well tamped concrete and pavement can be replaced immediately. If the ditch is wet replace earth and put loose crushed stone on top and allow the ditch to settle before concreting and restoring pavement. In all cases concrete should extend 8 inches beyond the width of trench.

MR. J. M. DIVEN: No matter how carefully dirt is put back in a ditch, or how thoroughly it is rammed in, on paved streets, passing vehicles will work it out, leaving a hollow. To avoid this the speaker has mixed the top layer, to a depth of 6 or 8 inches, with cement, using the cement in the proportion of one to seven or eight of gravel. This has made a filling not easily or quickly displaced by passing vehicles—a filling that has lasted until the pavement was permanently replaced.

With pavements having a concrete base, the speaker has beveled the edges of the old concrete, so that the patch acted as the keystone

of an arch, or went in as a wedge, making the patch somewhat thicker than the original concrete foundation, and bringing it only to the top of the old concrete, then, as a temporary surface, filling in with cement mortar, one part cement and three parts sand, up to the street surface, first putting a sheet of tar paper over the concrete base, so that the top finish can be easily removed when the permanent surface is put on. This has been found a very satisfactory way of making temporary repairs, the cement mortar making a smooth surface and one that will last for several months if necessary, yet may be easily removed when the pavement repair gang comes along. In the smaller towns it is usual for asphalt pavement repairers to come around once a year, so that some fairly permanent repair job is necessary for asphalt streets. There is a cold asphalt surfacing material on the market, but the speaker has had no experience with it.

MR. OSCAR BULKELEY: In Rockford, where we have brick pavement with concrete base to take up, we first fill the trench, tamp the dirt thoroughly, then place the brick immediately upon the top of the dirt. It is then left for a period of a week or ten days until the trench settles, after which a concrete base is laid with the brick on top. For asphalt cuts the concrete base is placed with paving brick on top. In our city the street department takes care of the asphalt cuttings of that kind at a regular time each year. The brick pavement merely takes the place of asphalt for a year or less.

MR. J. M. DIVEN: Is not that rather unsightly?

MR. OSCAR BULKELEY: A little bit, but it is better than leaving a hole in the street.

MR. MORRIS R. SHERRERD: Our practice has been to put in sewer, water and gas connections, for every lot, vacant and otherwise, before a street is paved.

MR. J. M. DIVEN: That does not solve the problem, often a service of a different size or in a different location is wanted when a building is put up.

MR. MORRIS R. SHERRERD: No, but it reduces the cutting of the pavements to a minimum.

Question No. 5: Should private fire services be shut off, in case of fire in sprinkler protected buildings, as soon as the fire department reaches the fire and is in action?

MR. H. P. BOHMANN: No. It would be dangerous to attempt to shut off a valve in the street while the department is fighting a big fire.

MR. CHARLES H. SMITH.[1] The automatic sprinkler is the most effective agent known for the extinguishment of fire. Its efficiency is shown not only by the number of fires extinguished in their incipiency by from one to a dozen sprinklers but also by the many fires which are held in check by the sprinkler system even though for various reasons the first sprinklers which open are not able to fully extinguish it.

The experience of the Factory Mutual Fire Insurance Companies furnishes a striking illustration of the value of sprinkler protection. While today the factories insured in this system are completely sprinklered and their general fire protection has reached a standard of excellence not exceeded by any other class of property in the United States, yet their beginning was in the days before automatic sprinklers were invented and at first these properties were simply protected by private hydrant systems, hose standpipes, and the like. After the invention of the automatic sprinkler in 1875, sprinklers began to be introduced into these factories. During the ten year period from 1877 to 1887, it is estimated that not more than one-quarter of the property thus insured was equipped with automatic sprinklers. For this same period, we had 759 fires without automatic sprinkler protection, with an average loss per fire of $7500, and 206 fires with automatic sprinkler protection, average loss $1080, showing an average loss per fire without sprinklers seven times as great as that where there were sprinklers. Naturally, in those days the sprinkler systems were somewhat crude and not so effective as they are today.

The General Fire Extinguisher Company keeps a record of fires occurring under their sprinklers and their *Bulletin* of April, 1914, relates that up to that date 13,678 fires in America have been reported. Of these no claim for insurance was made on 8213, and on the remainder, 5465, the average loss per fire was $267.22.

[1] Engineer and Special Inspector Associated Factory Mutual Fire Insurance Companies.

The National Fire Protection Association has gathered the statistics of fires in properties having automatic sprinkler protection since the organization of the Society in 1897. From 1897 to 1914, 14,714 fires were reported in sprinklered risks. Of this number 95 per cent are classified as satisfactory fires, that is, where the fire was either extinguished by the sprinklers or held in check by them; 63 per cent of these fires were practically or entirely extinguished by the sprinklers and 32 per cent held in check; 85 per cent of the whole number of fires were controlled by 12 sprinklers or less, and the number of cases where over 100 sprinklers opened was but 2.7 per cent.

SAFEGUARDING HUMAN LIFE

So much for the automatic sprinkler as a protection against property loss, but it has a function beyond that which up to date has been little appreciated. Industrial establishments protected by automatic sprinklers have been almost free from loss of life by fire. Since the inception of the Factory Mutual System in 1835, there have been but thirty-six lives lost in fires in our factories and twenty-one of these were in an unsprinklered mill in Fall River in 1874 before sprinklers were generally installed. So that during the last forty years, since the introduction of sprinklers, there have been but fifteen lives lost by fire in these factories, where there are now employed at least a million and a half people every day.

DANGER OF THE CLOSED VALVE

The automatic sprinkler cannot perform its function without ample water supply. Given a proper installation of sprinklers and excluding a few examples of special hazard, the cases where fire has progressed beyond their control are due to either one of two things, namely, the valve controlling the sprinkler system was shut at the start of the fire, or the sprinklers were shut off too soon. Closed valves we are constantly trying to guard against, not only by our quarterly inspections, but also by stimulating owners to rigorous self-inspection. In cities, automatic supervisory service of fire apparatus by the telegraph companies has been inauguarated to the same end.

That sprinklers may not be shut off too soon during a fire, a feeling of confidence in what the automatic sprinkler is able to accomplish

must be established. It is not strange that people not familiar with sprinklers may feel somewhat sceptical as to the final outcome at a fire which has filled the room with smoke, and immediately think it necessary to resort to hose streams, believing that water used otherwise is being wasted. Experience teaches, however, that if a sprinkler equipment is amply supplied with water, you may feel reasonably sure that the fire will be taken care of.

Good judgment is certainly required that the sprinkler system be not shut off too soon. Sometimes those in charge, believing the fire to be extinguished, have shut off the system prematurely, with the idea of preventing further water damage. Events showed, however, that the fire had not been completely extinguished, and gaining headway with the sprinklers shut off, a considerable loss occurred before the fire was brought under control.

QUANTITY OF WATER USED BY SPRINKLERS

The automatic sprinkler works at the seat of the fire and commonly performs its work with the use of very much less water than would be needed, were hose streams entirely relied upon. The discharge from a sprinkler, of course, varies with the pressure, but on an average it may be taken at about 20 gallons per minute. We may therefore figure that 12 sprinklers would discharge 240 gallons per minute and protect floor space of about 1200 square feet with practically the same amount of water that would be used by one hose stream, with a $1\frac{1}{8}$-inch nozzle, which at the lowest effective pressure would discharge about 250 gallons per minute. While not wishing to belittle the hose stream as a secondary line of defence, there is no doubt that a large part of the water used by hose streams in fighting fire is actually wasted, and worse than that, large and unnecessary water damage inflicted in some cases.

This fact is becoming generally recognized and it is now the order in some of our large cities, notably New York, Philadelphia, Chicago, and St. Louis, that the fire department on arriving at a fire shall couple up either the first or second stream to the steamer connection to sprinklers when such exists, in order that the sprinklers may have the benefit of high pressure from the steamer in the early stages of the fire. In New York it is compulsory to provide such steamer connection when installing a sprinkler system. This matter is of immense importance in high city buildings as the highest pressure hose streams will not reach above the sixth floor.

CONTROL OF SERVICES

With sprinklers well supplied with water, the cases are rare where fires gain such headway in a sprinklered building as to cause sufficient destruction to seriously cripple the system and waste water from broken pipes. From the statistics quoted at the beginning of this paper, such cases would amount to 2.7 per cent only of the whole. That even this remote contingency may be taken care of, we in our work always arrange to control the supply to sprinklers in the building by a safely located outside indicating valve. Primarily, however, the reason for an outside controlling valve is that when it becomes necessary to shut off a system for legitimate repairs, we may be able in case of fire to turn water into the system without the necessity of going inside the building.

In considering the possibility of waste of water in buildings on fire, there is very much more to be apprehended from the breakage of pipes entering unsprinklered buildings for domestic supply or for the supply of elevators, etc., which commonly do not have the valves controlling them conspicuously or safely located, and more wisdom would be shown in demanding that accessible valves be placed on such service connections.

Decidedly the fire service to a building equipped with automatic sprinklers should not be shut off as long as the building is intact; and if the automatic sprinkler equipment in that building is properly supplied with water at the start of a fire, that means that rarely will it be necessary to shut off the equipment until the fire is extinguished. The first duty of those in control of water supplies at a fire should be to see that water is *surely on* the sprinkler equipment rather than to turn it off. To do otherwise in the early stages of a fire is to spike your guns on the eve of battle.

MR. J. M. DIVEN: Until recently the speaker firmly believed that sprinkler services should be shut off as soon as the fire department took charge at a fire, but, while watching a fire in a sprinklered building recently, he realized that the sprinklers were in action in parts of the building not reached by the hose streams. The automatic sprinklers were not hampered or confused by smoke, but always put the water where it was needed. Of course there should be someone present to shut off the sprinklers when the building begins to fall, or falling floors break the sprinklers; also the sprinklers should be

shut off when their draft lowers the pressure enough to cripple the fire department service. But, while there is plenty of water for both the sprinklers and the hose streams, the speaker is firmly convinced that the sprinkler service should be left in action while the building is intact, or while there is any chance of saving it.

MR. P. GEAR: The paper read by Mr. Smith on the shutting off of private fire service was well prepared. The speaker does not believe in the shutting off of private fire services. The insurance men and firemen are the parties who would have to settle that question. When the firemen are called out to fight a fire, they are supposed to have full control over it. The speaker has never known where any harm was done to a water service, in our city, owing to the water not being turned off. It would seem that it is not a very good idea to turn off the water from a mill, where there are sprinkler heads in places where the firemen can not reach the fire, but if the water is allowed to run it may do some good. It might be well to let the water run but shut off the gas.

MR. C. H. SMITH: The gentleman from Holyoke has not, in the speaker's opinion, taken sufficient credit to himself, so he would like to say a word as to what he believes to be the custom in Holyoke, understanding that at every alarm of fire there the Water Department sends out a man to make sure that the water supplies to fire services in the mill yards or buildings are free and unobstructed, and that the street hydrants are properly supplied; that is, if there are any valves improperly closed, it is his duty to see that they are opened.

MR. W. H. RANDALL: Some time last fall we had a very serious fire in the city of Toronto, and the firemen on arrival at the fire connected up to the fire hydrant. When the first stream was put on apparently the pressure was all right; but they connected four streams, and the pressure was all wrong, notwithstanding the fact that our high level pumping station and everything else proved to be normal. This became a very serious question in the city of Toronto with regard to the pressure of water. Since then, we have adopted this system: every fire alarm that comes in, whether it is night or day, a gong rings in the office and men are tolled off to answer the call. It is their duty to go to the fire and see that the pressures are taken with gauges and taken from hydrants not in use, circling the

fire district. Since adopting that plan, we have never had any complaint of any lack of pressure as far as the water works department is concerned.

Question No. 6: Experience with annoying noises caused by working of water meters?

MR. H. P. BOHMANN: Sometimes caused by a broken meter disc. In several instances we found the cause to be iron pipe carried overhead.

MR. A. A. REIMER: We have had quite a number of complaints of noisy meters, and in fully nine out of every ten cases we find that the fault is not in the meter direct, but is due to the faulty construction of the piping system in the house, which simply acts as a telephone or vibrator carrying the noise all over. When we get complaints of that kind we send a man to investigate. He puts a few pieces of felt between the pipes, and then there is no more trouble from noisy meters. In the few cases where the noise is directly attributable to the meter, we find that something has gone wrong usually in the gearing, which allows more play than there should be to the working parts.

Question No. 7: What is the correct or best way of testing water meters? Is it practical to test meters, especially large sizes, in place?

MR. H. P. BOHMANN: By running a definite amount of water and weighing same. Large meters can be tested best on premises with a test meter if a testing tee is inserted between the outlet side of the meter and the outlet meter valve.

MR. WILLIAM VOLKHARDT: All meter manufacturers test small meters by weight. Get a good reliable scale and weigh the water, so that you will be less liable to err. Large meters may be tested in place, although the best practice is to send them to the testing plant.

Question No. 8: Experience with straight line reading meters—are they preferable to the clock dial meters?

MR. H. P. BOHMANN: Clock dials are less apt to get out of order as all gears are in constant motion. In a straight reading dial the higher reading hands are idle too long and often corrode.

MR. WILLIAM VOLKHARDT: If you have a straight reading meter you eliminate the mystery, and may place the entire responsibility of the meter bill upon the consumer. If the consumer complains of a large bill, you can take the position that you have no control over his or her personal affairs, as it is the duty of the consumer to make periodical readings and keep track of the consumption. This position you cannot take very well if you furnish a round dial meter, because you all know it is difficult to read.

MR. J. DAVIS BARNETT: This question brings up the matter of the man engaged and not the machinery; for there is a possibility of error in reading the dial gauge, which there is not in the straight reading meter. That was once brought home to the speaker, because he remembers that one of the first things in connection with water works that he did was to sign a refund check for $1100 for a reduction on bills that had been made up on dial readings, furnished month after month jointly by an employee of the water works and of the company that was receiving the water. That shows how long an error can continue. Since changing to straight reading meters, there has been no complaint and no cause to believe that there was a misreading of the straight line register.

MR. W. R. YOUNG: With reference to the straight reading meter and the statement by a previous speaker that they never find any mistakes in reading such meters, we have in Minneapolis 46,000 meters in service, about 45,000 of which are round dial. Our men are all hired by the month, and they work twelve months in a year. They become as conversant with the reading of that type of meter as any person does with regard to telling the time of day by an ordinary clock or watch. That is the case, no matter whether the face of the meter by the action of water and chemicals is entirely obliterated. The readings of the meter are nevertheless taken with considerable accuracy and are found to be practically correct. But with the straight reading meters we have had more or less trouble. We have had considerable trouble with figures becoming obliterated on the straight reading meters; but we feel that if our inspectors are

instructed properly they will read the dial reading meters just as well as they could tell the time of day by the hands on a clock.

MR. C. W. WILES: The most serious objection to the straight reading meters has been that the last counters become corroded and stick, as they move so slowly; the gears stick before you have a chance to use them at all. We have had to send them back to the factory on that account. The meter manufacturers, themselves, will tell you that that same question has given them a great deal of concern.

MR. GEORGE HOUSTON: The last speaker is probably using a meter that has not the proper kind of register in the straight reading meter, or he would not have that corrosion or sticking that he mentions. We have about 7000, and with some makes we have never had any trouble of the sort described. The speaker is prejudiced in favor of the straight reading meters, because he feels that the round dial has no excuse for existence. One man does all the reading of our 7000 meters, and we are satisfied that one man will do at least twice as much in the line of turning in reports on straight reading meters as he will on round dials. Scarcely any mistakes are made on the straight reading meters; whereas on the other kind we have had mistakes that caused a great deal of trouble, and many of them. Anybody who has anything to do with reading meters knows that many times the people are not at home, so that the meter reader fails to get in and get the reading. Our men have sometimes had to go back four or five times on this account, which necessitates an enormous amount of travel. That, too, adds to the cost of reading the meters. If a meter reader finds that the lady of the house is not at home, he can leave a memorandum, if there is a straight reading meter in the house, requesting her to send the reading in to the office; but if it is a round dial the lady cannot do this so well. This system gets them in the habit of reading the meter, and they will telephone the reading in themselves, saving your men the trouble of going back again. Taking it all together, we save thousands of miles of travel for our meter readers by using straight reading registers, and are able to collect our bills more regularly than we could if we used the round dials.

MR. W. H. RANDALL: You say that you have 7000 meters, and that just one man does the reading? How often are the meters read?

MR. GEORGE HOUSTON: Yes, one man reads them all every quarter.

MR. W. H. RANDALL: Is that the custom in the United States, to read quarterly?

MR. GEORGE HOUSTON: That is the way we have been doing for the last 10 or 15 years at Kalamazoo.

MR. WIRT J. WILLS: If the gentleman can get one man to read 7000 meters, the speaker will have to revise his opinion, which has not been in favor of the straight reading meter. We have 16,000 meters and 12 men reading them, evidently something wrong with us. The reason that the speaker objects to straight reading meters is, as a previous speaker said, that they are apt to become corroded and the dials turn very slowly. We have discontinued them on that account.

MR. EARL W. KELLY: Our method of obviating the difficulty, in case the meter reader does not find anyone at home, is this: We furnish the meter reader with a little printed card to the effect that the meter reader has called and found no one at home, with the request that the party fill out the reading on the card. On the back of the card is printed a facsimile of the dial of the meter, and the consumer simply marks in pencil on each dial the position of the corresponding hand on the meter dial.

MR. GEORGE HOUSTON: The round dial meter would not be so bad, were it not for the fact that on some of the meters each hand revolves in the same direction, while in others, every other hand travels in an opposite direction, which is confusing. Some of our men who have been in the service seventeen years we find will make about as many mistakes reading the round dial meter as a green hand; so how can you expect a novice, particularly a lady who has to go down cellar to do it, to read a round dial meter with the same accuracy that she would a straight reading meter? We have in the neighborhood of 6000 straight reading meters, of all kinds, and on an average of not more than three of those meters stick in the upper register during a year. We have never had any of one company's make stick, no matter what kind they were, for the reason that the shaft

on which the counter tumblers revolve moves every time a fractional part of a foot of water goes through and keeps the bearings perfectly limber so that they cannot stick. Examine the different makes, and you will find that some of them cannot stick.

MR. THOMAS HODKINSON: With regard to what Mr. Young said, we have had the same mistake occur with one of our meter readers. It is very easy to read the units in place of the tens. In one year in the case of one large consumer there was a difference of $1000. With regard to the clock dials, we find that we can educate a man to read a clock register correctly in about two days. We break them in to read about 100 meters a day; that is about all they can do, and it keeps them going for nine hours. We have had straight reading registers stick. With regard to the shaft turning around, there is more than one kind of a register; some have the shaft stationary. Some of the meter manufacturers are making them that way now; but they have been making them where the cogs move around on the shaft, and where the consumption is small, they corrode; this causes them to stick.

MR. A. A. REIMER: What kind of territory did the previous speaker have to cover? He spoke of his men reading 100 meters a day. Is his territory scattered so that the meters are far apart?

MR. THOMAS HODKINSON: No, they are close together, but there are very few put in on the streets. Nearly all are put in the basements.

MR. A. A. REIMER: It seems as though you are getting a very low figure.

MR. THOMAS HODKINSON: If our meter readers notice a large consumption they locate the reason for such and if there is a leak the consumer is notified right on the spot to have it repaired. This keeps down any complaints which may occur when the bills are rendered.

MR. A. A. REIMER: We are getting 125 to 150 from our meter readers, over scattered territory. It sounds like a very low figure when you say 100 a day.

MR. W. H. RANDALL: The gentleman from London says that his readers are practically inspectors as well as readers. They go through the premises to find out leaks, and thus are practically doing the work of inspectors.

MR. A. A. REIMER: The object of the meter is to put an automatic inspector on services. It seems as though you were going to an unnecessary expense when you put a human inspector on with an automatic machine inspector.

MR. THOMAS HODKINSON: We usually do that to keep down complaints, and keep our metered consumers better satisfied.

MR. CHARLES S. POTTER: We thoroughly tested four different makes of meters equipped with straight reading dials. With the exception of one type of meter, results obtained were unsatisfactory, and we have discontinued using the straight reading dials. The speaker is anxious to get some information as to the reading of meters. Our city has approximately 40,000 services, only 10 per cent of which are metered. They are, therefore, badly scattered over the city, but are placed on the sidewalk and are accessible at all times. We are unable to read more than an average of 150 meters per day.

Regarding complaints, we find it advisable to investigate unusually large consumption at the time the meter is read instead of waiting until complaint has been made by the consumer.

Question No. 9: Legal decisions concerning "Averaging rate" when meter is out of order and not registering?

MR. CHARLES S. POTTER: About six months ago, a decision was rendered in the Jefferson Circuit Court of Kentucky along that line.

A meter that had been in service approximately twenty years, was removed, and a new meter installed.

The Court ruled that the plaintiff would not be permitted to introduce any evidence regarding previous readings as shown by the old meter; in other words, the reading of the new meter, which was proved to be accurate, must be taken, regardless of past averages.

This case is now in the Court of Appeals.

MR. ROBERT A. JACKSON: We had a case like that. We took the previous three years' quarterly statements, added them together, and divided by 3, and rendered the bill on that basis. The consumer objected to that, and we said, "All right, we will let you go on for three months and we will render a bill on that basis." What did he do? Why, he did not use any water at all, and he said that he had not used any in the previous nine months.

Question No. 10: Possibility of and conditions governing over-registration of meters?

MR. H. P. BOHMANN: Velocity type of meters sometimes over-registered when meters get clogged.

MR. J. DAVIS BARNETT: Quite recently the mechanical engineer of a very large company appeared before us and claimed that an eight-inch meter running steadily at 80 pounds pressure can over-register to the extent of one-third of a million gallons per day. We would not accept his claim in that case. If anybody has experience as to over-registration or over-running of meters, would like to have him give his experience.

Going back some thirty-five or forty years, almost too long to give all the details of the matter, and referring to a communication in *Engineering* of London, England, which mentioned a case where a pipe was cut and a meter inserted. There was a long system forward of the meter, with a long dead end not in use. The whole length of this pipe acted as an air chamber, with the result that when the water was turned on it flowed through the meter and backed up the air, and afterwards (when shut off) the air quietly recovered without unwinding the register. That is the single case within the speaker's knowledge. In the case previously referred to, where it was said that we were over-registering one-third of a million gallons per day, there happened to be a shut-off valve just forward of the eight-inch meter. We tapped the pipe, put a small meter in, and let the water escape through the small meter, and the difference in readings between the two meters was only 1 per cent.

MR. P. GEAR: We had a little experience this year with a meter. We always told manufacturers and consumers that this particular make of meter would not over-register and will have to apologize to some of them. There is a sixteen-inch meter on one of our main

lines coming from our reservoir. Two of the four lines supply part of the residential portion of the town. One comes down town regulated by a valve. We had a suspicion that there was something wrong with this meter on account of the amount of water that it was registering as coming from the reservoir and the amount of water that was left in the reservoir. From our calculation of the amount of rainfall and the amount of water in storage in the reservoir, we suspected something wrong, but we did not discover what it was until along in the fall of the year, when, business being slack, we went around looking for trouble. Our consumption did not go down in the winter, as it ought to have done. We shut off the meter that supplied 5000 people in the upper section of the city. It was showing a consumption of nearly 800,000 gallons a day for the residents of that section, which seemed too large. We found a two-inch plank seven inches square in the throat of the large meter which put more than the proper proportion of the water through the small one. When the obstruction was removed the meter showed a consumption of 350,000 gallons where it had been showing 800,000.

MR. C. W. WILES: The speaker has offered consumers oftentimes to take out and test their meters, and if they over-registered 2 per cent to give them the amount of the entire bill, and has never been caught on it yet; but did learn of one meter in Michigan some years ago that showed an over-registration of about 25 per cent. What do you suppose was the trouble in that case? They found that the assemblers at the factory had put in the wrong spur wheel on top; that was all there was to it and that was corrected. The speaker has never heard of a small meter that over-registered; but they will under-register slightly when they are new.

MR. J. M. DIVEN: On complaint of over-registration of a four-inch meter, it was taken out, tested, and found to over-register. It was then sent to the factory to test and repair. The explanation of the over-registration was that the meter was very dirty, and that the over-registration was caused by the reduced area of the measuring chamber, due to the accumulation of sediment in it. This was a disc type of meter. The moral of this experience is that, when using turbid or highly corrosive water, the meters should be cleaned often. However, cases of over-registration are few as compared with under-registration of worn meters.

MR. CHARLES S. POTTER: Our department in the past has also offered to give the consumer the amount of the bill if they could find that the meter was over-registering. Recently we found it advisable to discontinue this offer, for out of 110 meters, three, four and six-inch, velocity type, purchased two years ago, about 50 per cent, after from six to eight months' service, have over-registered from 3 to 11 per cent. The engineering force sent by the manufacturer reported that the over-registration was due to a peculiar vegetable formation which adhered to the rubber piston. This slight deposit varying in thickness from one sixty-fourth to one thirty-second of an inch caused a slight reduction in area of the helical blades. When the meters were taken apart and thoroughly washed, they would drop back to accuracy in registration.

MR. W. J. WILLS: We do not guarantee plunger displacement meters very much, but in our city if a meter is fast, we offer to give a suit of clothes; we have never had to give a suit of clothes yet, but came very near it. The water in Memphis is impregnated with iron, not dirt, but iron sediment. Little particles of iron adhering to the working parts of the meter reduced the capacity so that, although it was 5 per cent slow five years ago, when we tested it out it was 3 per cent fast. There was a difference of over 7 per cent in a little over five years.

MR. WILLIAM LUSCOMBE: We had a single case in Gary, Indiana. About three years ago we had a case of a meter that over-registered about ten times the water that passed through it. This was due to a mistake in placing a register and combination gears for a large meter on a small meter. We had a refund of about $500 to make to the consumer.

MR. W. H. RANDALL: The speaker devoted a great deal of time to the study of meters some years ago, and gave some of them very severe tests. We had one on what was known as "Foresters Temple" in Toronto for seven years, a type of meter that is not common in this country. The impeller has wings on it, which govern the rate due to the velocity with which it travels. There was a dispute with regard to the consumer's bill. The meter tested within one per cent notwithstanding the fact that it had been on for seven years. The bill was settled, and everything was satisfactory. After the

settlement was made, we had the meter taken apart, thoroughly cleaned, and put together again. Nothing was done to it otherwise. After cleaning we put it through the same test, and it was found to be 5 per cent fast; showing quite clearly that the meter, being of the velocity type, but dirty and sluggish, was not fast while in service; but after cleaning it showed quite clearly that whatever little particles had stuck to the side of the cylinders where the impeller ran had worn off the wings to such a shape that after it was cleaned out and put in shape again it was necessary to spread these vanes out more, to make it come back to its proper recording condition.

MR. A. W. CUDDEBACK: There is one type of meter which is probably ahead of any other in the possibilities of over-registration. This is the current meter, and the excess registration may be 4 to 5 per cent up to from 40 to 50 per cent. In the cases examined, and we have had several, the cause of the over-registration was found to be due to the choking up of the port, increasing the velocity of the vanes. That type of meter needs continual watching. By testing twice a year we generally catch these little differences. In one case the over-registration was as much as 40 per cent, due to the choking up of the port. In regard to the domestic or ordinary disc meter, we have never had an over-registration of more than 4 or 5 per cent, and this was undoubtedly due to a slight coating of the disc chamber. The current meters need careful watching in order to secure continuously correct registration.

MR. WILLIAM VOLKHARDT: If this discussion on over-registration of meters is printed it might lead some to believe that all meters over-register, and it is not the intention of the members of this Association to give out that impression. There have been a lot of things said here that it would be well to keep out of print, because each speaker has described a reason for the over-registration due mostly to an accumulation in the meter, or some similar cause. Summing up the entire discussion, the percentage of over-registration is infinitesimal compared with the number of meters in use. The house type of meters as a rule do not over-register. If we are going to infer that they do, am afraid you will get into lots of trouble.

MR. W. J. WILLS: On an average we take out on account of running slow 150 meters a month, from a total of about 16,000. In some cases they absolutely stop all movement.

MR. A. A. REIMER: In connection with the fact that the trouble with disc meters is under-registration on small streams, we issue a pamphlet to our customers, in which we not only try to teach them how to read their meters, but also make a plain statement like this: "The meter placed in your house is as accurate as an ordinary watch." And we stand back of that statement too. We have had to take out hundreds of meters to test them on the application of the consumer, for which we require a deposit of $2, with the understanding that if the meter is found to be fast 3 per cent or more, the bill will be adjusted. If not, we keep the $2. We have never as yet had to give the $2 back; in fact, we advised our consumers not to call upon us to make a test, so sure are we that the meters will not over-register.

Question No. 11: Should meters register cubic feet or gallons?

MR. A. P. FOLWELL: In some data collected on meter readings, out of 285 cities 210 show the records in gallons, 75 in cubic feet. This is presumably a large enough number of cities to give a fair idea of the general practice, it would seem.

MR. J. M. DIVEN: There is one advantage in the gallon method of registration; the ordinary consumer who makes a complaint and wants his meter tested knows what a gallon of water is, and does not know very much about cubic feet. In making tests it is an advantage to have meters read in gallons. It also saves some work in the office, in making out bills.

MR. C. W. WILES: Reading meters in gallons is a very cumbersome method and the trouble connected with reading meters would be multiplied if you figured them all by gallons. The speaker prefers cubic feet, and believes that the dials are more easily and quickly read under that method. For the last few years we have used cubic feet instead of gallons. Our original rate was 25 cents per 1000 gallons; but is now 20 cents per 100 cubic feet. It was found that 20 cents per 100 cubic feet, less 10 per cent, was practically equal to 25 cents per 1000 gallons, with a slight difference in favor of the consumer. It works very satisfactorily indeed, and eliminates all the trouble that you will have if you work it out by gallons.

With regard to the small disc meter, the longer it is in use the more water it will slip. The disc is wearing all the time, and the gears

also wear, consequently more water comes through the meter than ought to after it has been in service four or five years.

MR. A. A. REIMER: The speaker would like to say a word about dial meters. The figures Mr. Folwell has given us are surprising. The consumers in this country in cities where gas is in use do not know anything about a gallon of gas, but they do know that they are charged so much per 1000 cubic feet of gas, and if they use electricity they are charged by the K.W. hour; but they do not know what it means in ninety-nine cases out of a hundred. There is a tendency, not any too strong as yet, but the tendency nevertheless exists, toward the use of the metric system in a great many kinds of work. The time will come when we will discard cubic feet as well as gallons, and we will have the cubic meter, or kilometer or cubic centimeter, or something like that.

MR. WILLIAM LUSCOMBE: It seems a common sense proposition that if water is sold on a basis of cubic feet that the cubic feet registration would save a great deal of figuring by the clerical force in arriving at the amount of the bill; whereas if it is sold on a gallon basis, the gallon registration would be preferable.

Question No. 12: How should house hot water boilers be cared for when water is shut off; what instructions should be given to occupants of houses?

MR. H. P. BOHMANN: If boiler is supplied directly from the main, keep up only moderate fire, and open hot water faucet, and shut the cold water faucet, and do not allow any air to enter the mains until the water is again turned on.

MR. J. M. DIVEN: This is a question, gentlemen, that you ought to discuss and we all should have a uniform system. It is often necessary to shut water off for repairs, as we know, and the householder comes to the water works superintendent to know what to do with his hot water boiler, whether it is necessary to let the range fire out entirely. In looking over the rules and regulations of various water departments, find a decided conflict in the instructions given in this regard, and it seems as though some of the members ought to have some experience that would help us out.

MR. P. GEAR: We notify the people that we are going to shut off the water. If the reason for shutting off the water is that there is a broken spindle in a gate, we tell the consumer that according to our previous experience the water may have to be shut off for an hour. Where a gate is broken and the spindle is broken it is hard to shut the gate down because of corrosion. In removing the spindle from some of the gates that were constructed forty years ago, and which we find still in use in our place, we do not find that the gates that are made today are any material improvement over the earlier models. The stuffing box in the older time used to be made of cast iron; the gland was made of cast iron and the top of the gate was cast iron, so that there was nothing to protect the spindle from rust. We found some spindles that we could not take up at all. The bolts that held the stuffing box and the gland together were iron, and the gate was iron, and you had to take that bolt off, perhaps cut it off, and the gland would be rusted sometimes so that you could not turn the spindle. We would tell them that we were going to shut the water off for an hour; but after we took all those things off we would find that the gate was not tight and we would have to keep the water shut off for three hours.

A gate would be free from rust and dirt longer and could be more easily taken apart and cleaned if it was constructed with a brass gland; brass lined stuffing box; top of gate brass lined where the shoulder of the spindle rests; brass bolts and nuts in the stuffing box and slotted for easy removal; the rings in body to be set out one-half inch or more and have a space of one inch on the sides and two inches on the bottom to keep the dirt away from the gate and rings. A gate so made ought to cost but little more than those at present on the market.

MR. W. H. PECK: We notify the people in the territory affected that the water has been shut off. We shut it off for an hour or more if required to complete our work, instructing them to open the hot water faucet and bank their fires. If there is a hot fire on and too much steam generated, if the faucet is left open, it will escape and there will be no danger of exploding their boiler.

In reference to what the last speaker said of gates leaking and passing water, that is a very frequent occurrence, and perhaps the speaker can give some experience which may be valuable although it does not come from one who has been long in the business and who

has found out all of the good methods. When he finds a gate that does not shut tight his practice is to open a fire hydrant in the shut off area and then crack the valve, that is, open it a few turns; the rush of water through the narrow opening carries with it all sediment from the valve seat or recess at the bottom, and the gate will then shut down tight.

MR. P. GEAR: There is not a man in the country who when he goes to shut off a gate will not go back and put his ear down and if he hears the water whistling through he will open it up and shut it down, until it is tight; but after making a certain number of turns they will think they are close to the line where they cannot shut it off any further. If a man finds that he cannot get it tight enough he has to go back to another section. Every man that has anything to do with gates and water works breaks a spindle once in a while when trying to shut a gate down, especially when a big strong husky fellow is told to shut the gate down. He will pull it until he breaks it. If he does not break it in closing it down he will when opening it.

A MEMBER: We have a rule saying that all hot water boilers connected with our service must have check valves as a matter of protection. This puts the responsibility upon the owner of the boiler, and is a good thing.

MR. E. W. HENRY: If the stop-cock on supply pipe to boiler is shut off, and the hot water faucet left open, there is no possible way of the boiler siphoning out.

MR. J. E. BROOKS: The speaker would like to change the wording of that question so that it would cover not what instructions should be given, but does anybody know of any damage that has resulted when water has been shut off?

SECRETARY DIVEN: That question was up last year. You will find it with discussion in last year's proceedings.

MR. JOHN CAULFIELD: We have a rule that requires check valves on every service. We will not turn the water on until those check valves are installed.

MR. E. W. HENRY: A copper boiler will collapse when the water siphons out of it. It costs our city about $30 or $40 to make good such boilers.

MR. P. WALSH: The speaker would like to ask for his own information and in order to get right on the subject as to whether the use of check valves does not make the danger greater when you shut off the main. You are saving the meter, but are you not increasing the danger of explosion?

MR. JOHN CAULFIELD: We require a blow-off or relief valve also.

Question No. 13: Do you use check valves on metered services, if so, why, and what benefit do you derive from them?

MR. H. P. BOHMANN: Only where a system is supplied from two separate lines of pipe. It avoids back registration when one line of pipe is shut off.

MR. WILLIAM LUSCOMBE: The speaker would like to ask those who use check valves at whose expense they are installed, that of the water works or the consumer?

MR. JOHN CAULFIELD: Consumer, in St. Paul.

PRESIDENT THOMAS: How reliable are check valves?

MR. A. A. REIMER: The speaker was a little surprised when Mr. Caulfield said that his enlightened town required check valves and also called for blow-offs on house boilers. You can call for all the blow-offs that you want, but when the blow-off is actually needed the chances are that it has not been used for ten years and that it will not work. That is a case where regulations do not regulate. It would seem that St. Paul has been very fortunate in not having any explosion under those circumstances, due to hot fires. In New Jersey we had a case recently involving a private company, and the speaker was consulted at the time in regard to it. The company had required checks on their services and the house boiler exploded. The woman had kept her fire going pretty strong, so that the generation of steam was sufficient to get beyond the safe limit. There was

considerable damage done and one or two people were injured, so that there was an element of personal injury involved as well as property damage. The testimony showed that all the check valves which were installed by the private company had a very small hole drilled in the check, as the speaker recalls it now a one-sixteenth inch hole. That was done to safe-guard the boilers. In this case the little hole had become stopped up and did not perform its function, with the result mentioned.

The speaker cannot understand why check valves should be required. Regarding the slight damage that could come from hot water backing down into the meter, there again you could put it up to the consumer. There are very few of these cases. The element of danger is one that we should consider, as involving a possible explosion and loss of life.

MR. A. W. CUDDEBACK: The Public Service Commission of New Jersey some little time ago had occasion to rule on the question of check valves. The matter came up on a complaint that was brought by property owners, and in the case of a private water company, they required them to install check valves on the service pipes. The speaker was asked to give his opinion before the Public Utility Commission on the subject as to whether it was a proper and reasonable regulation; and his opinion was that it was not a reasonable regulation. He agrees with Mr. Reimer that the question of putting on check valves is one that can be put up to the consumer, and is not a very important question anyway. The Commission ruled against the check valve.

MR. WILLIAM R. YOUNG: This question involves loss of life. Several years ago in Minneapolis this question came up to us in regard to the necessity of putting a check valve on the sidewalk of a factory. We found a lawsuit was pending, and it looked as though the city was going to be made a party to it as one of the persons responsible for the damage; but after investigation it was found that there was no check valve in, but nevertheless an explosion occurred. The valve was closed by somebody in the plant and the hot water boiler blew up and killed a man. After that the city attorney advised very strongly against the city requiring check valves because he said that thereby the city could be held responsible in case of any damage.

MR. W. H. RANDALL: The speaker differs somewhat with some of the statements in regard to the use of check valves. Suppose, for instance, that a break takes place on a main and you have no time to notify the property owners that you are going to shut the water off. Suppose that a boiler siphons out, which you know happens very often, while your men are at work repairing the main. When the repairs are made you immediately turn on the water and there is just as much danger from the cold water coming back and into the boiler or hot water front as there is if you had a check valve holding the water in. As a matter of fact the consumer has no more right to expect to use the water mains as an expansion tank than we have. That is why we expect them to put a relief valve on their boilers to protect their own premises. Looking at it from a municipal standpoint the property owner must protect his own plant, and the use of check valves is the only safe way. If people are properly educated to it they can thereby protect the buildings or plants in the case of emergencies.

MR. P. GEAR: We find the same trouble with check valves that we do with gates. The speaker has never seen a check valve that would hold water after it had been in a year or two. They may make them that will do so somewhere else, but they do not sell up our way check valves that will hold water. We require a double check valve in all mill services, to protect our mains from the canal water that the manufacturers use in fire pumps, but in small services do not consider them of much benefit.

MR. LOUIS L. TRIBUS: Mr. Ross has some information on this subject, but he is too modest to take the floor himself, so suggest that he be called upon to enlighten us.

MR. WILLIAM ROSS: Check valves were originally put in to prevent the meter registering backward when there was a break in the main and somebody opened a faucet in the house. There are cases where a meter registered backward more than the people had used in a previous year, because it happened to be the meter nearest to the break in the pipe and was registering backward on air. We had a meter in our house that every time the water was turned off on the main would promptly run backward when a faucet was opened. That meter registered backward a great deal more than it did forward.

We were located at a high point on the line and the pressure was off and on several times during the twenty-four hours. It was the only meter in the neighborhood, having been put on by the Superintendent to determine the amount of water used for lawn sprinkling. That meter not only registered backward but it made an interesting racket when doing it. A pressure regulating valve acts much the same as a check valve in case steam is generated on the range boiler and in no case should a steam generator be used without some kind of safety valve attached thereto.

MR. W. D. POLLARD: This question applies more particularly to range boilers. If the hot water faucet is left open when the water is shut off from the main there is little danger to the boiler either by the generation of steam or by the sudden letting in of the water when it is turned on again, provided the water does not remain turned off for a longer period than about ten hours.

MR. E. E. DAVIS: When we shut off the main we notify the property owner to open a hot water faucet. Sometimes we come across a chick-headed negro who doesn't know what a faucet is and the water siphons out when the main is shut off. We had a case where the boiler collapsed and being made of copper it went back to its usual size from the pressure and a little hammering. We had another case of a collapsed boiler, but the head of the boiler instead of being riveted was soldered on, the same as plumbers make a wiped joint. In that case we had to give them a new boiler. Our people are so well educated that just as soon as the pressure goes off they call up the office and ask "What shall we do with our hot water boiler, the water does not run out of the faucet?" We tell them, "Leave the faucet open until it does run."

The speaker has had a good deal of experience with check valves on hot and cold water, and has yet to find a check valve that does not leak. On one large plant we had an eight-inch check valve which was leaking. We took it out and put in two six-inch valves and still the water came back. That was due to bad workmanship. In another case where the meter was running backward the check valve was found to be leaking, just as Mr. Gear said is the case with gate valves. We require two men nearly three months every year fixing valves and placing them in working condition. Some valves at Richmond were put in in 1830 and are in use today; but they require to be looked after.

Question 14: Has any water department or water company ascertained what it costs per consumer to read meter, make out bill, deliver bill and collect bill; that is, total cost of reading meters, making out and collecting bills?

MR. W. S. CRAMER: The speaker has nothing to offer as to the cost of reading meters, making out and collecting bills. Our meters are rather closely located and we read 5600 meters in thirty-six hours by two men last month. It seems as though it does not take any more time to read 5600 meters than 3000.

MR. JOHN CAULFIELD: That beats us. We thought we were rapid.

MR. W. S. CRAMER: From the time we started reading the meters until the bills were ready was seven days. The meters are located on the sidewalk. We have mostly straight reading meters all set at the curb-line, with twenty-four-inch cast iron covers on the meter boxes and eighteen-inch extension dials on the meters. There is a small center cap on the large top. We use a twenty-inch concrete box, thirty inches deep; in the center there is a small cover six inches square, and in reading a smal stick about eighteen inches long with an iron shoe on the end of it is used to open them. All that is necessary is to raise the center cap so that the readers can see the dial. We never leave the dial tops down, because they are protected by the iron top. In reading it is generally a question of only reading one figure. We use the card system entirely for preserving the reading. These cards are distributed according to routes, and when they are taken out they are thrown in route form in their consecutive number so that a man can carry these cards in his hand, just slipping them one over the other and he can easily refer to the former reading. We never read the odd feet, we just read the nearest hundred; so that it is generally on the ordinary house service necessary only to read one figure.

We are troubled very little with moisture under the glass. Two years ago last February, in the extremely cold weather, we had a little trouble with moisture but we carried an extra man who broke the moisture loose. It possibly reduced the record a little at that time; but very seldom do we have any trouble with moisture.

MR. WILLIAM LUSCOMBE: How many errors in reading do you have in reading that number of meters in that short time?

MR. W. S. CRAMER: Not over ten or twelve. We use a buggy on the outside routes. Our town is laid out in such a way that we have a great many blind streets. One man reads up one side of the streets and the other man the other side, and then they drive back. After they get to the inside route they read on foot all the time, and two men will read 5600 meters in thirty-six hours.

MR. J. M. DIVEN: That is 80 meters per hour, a little better than one a minute.

MR. MORRIS R. SHERRERD: In this meter discussion perhaps it might be well to give you the benefit of a new arrangement that has been worked out by one of our men to be used in case the consumer resorts to the practice of reversing the meter, which we have sometimes found has been done even where the seals were left intact. We put a small change gear on the gear train that will make the dial register forward whether it is set in the line of forward motion or backward motion. When we found that the readings were dropping off and suspected that the consumer might be reversing his meter, we put on one of these reversing gears, without letting him know anything about it, so that he can continue to reverse his meter but it will still read forward.

Question No. 15: What is the average life of a water meter, especially the smaller size—five-eighths to one inch? Has any one any experience in regard to this?

MR. H. P. BOHMANN: Meters used for domestic use last from twenty to twenty-five years. From 150,000 to 200,000 cubic feet registration—should register about 50,000 to 60,000 cubic feet before requiring repairs.

MR. GEORGE HOUSTON: We have had meters in use eighteen years or more, some of them registering as much as 3,000,000 gallons; and with little or no repairs on the gears, after testing them, we found them to be accurate; so consider it is perfectly safe to assume that meters of some makes are good for at least twenty-five years.

MR. A. A. REIMER: In a recent report on certain work in New York City some of the consulting engineers reported the life of meters

at twenty years. Mr. John R. Freeman of Providence, R. I., is using that figure and doubtless others are; whereas perhaps five or ten years ago the reports on valuations of that kind would not show a higher meter life than twelve or fifteen years.

MR. WILLIAM LUSCOMBE: A tabulation of the Wisconsin Public Service Commission places the life of meters at twenty-five years.

MR. C. W. WILES: Does it not depend entirely on the character of the water? Where there is iron in the water no meter will stand up for twenty years according to the speaker's experience. Where the water is filtered you have a different proposition entirely. The meter is affected by the amount of turbidity as well as the amount of iron. Where there is more iron in the water the meter's life will be shorter; and we cannot therefore compare the life of one meter with another.

MR. P. GEAR: The question can be answered in a good many ways. The speaker has a three-fourths-inch meter that he thinks will last forever. It was bought about ten years ago and thought so little of that it is on the bench yet—it was never put in service. We have had some meters in service since 1874. After having registered 28,000,000 to 30,000,000 cubic feet of water, they have been taken out, repaired, and started off with a good prospect of lasting for many years more. Put in a meter where it has a nice gradual run of water, say 25,000 feet a month, and it will last for a long time, but if it runs off 25,000 feet in a couple hours it will use it up pretty fast. Some of the meters that they are making nowadays can be changed around and sent to the factory, repairs made on the interior parts, and the outside will last you forever. We have a meter that was put in use about ten years ago, that has registered 14,000,000 cubic feet of water and it is perfect yet; other meters that were put in about the same time pounded themselves to pieces in four or five years, so that they were only fit for scrap. It all depends upon the class of service that the meter is put on. Repairs to meters are made so gradually that we do not feel the cost; we fix them up as we go along, make new pistons, new discs, or whatever is necessary to renew the working parts, so that we make a new meter out of the old one every four or five years.

Question No. 16: Which is better, to maintain a meter repair department, or send meters to the manufacturers when repairs are needed, especially in the case of small water works?

MR. H. P. BOHMANN: We find it more satisfactory to repair meters in our own shop—too much delay and more costly to send to the factory.

MR. GEORGE A. MAIN: It would seem that the answer to that question depends largely on the location. It is not good practice to send a meter from Florida to the manufacturer for repairs; but in the heart of a manufacturing section near where the meters are made it might be a wise thing to send them to the manufacturer for repair.

MR. WILLIAM R. YOUNG: If one has only a half a dozen meters to be repaired it would hardly pay to run a small repair shop.

MR. C. W. WILES: We always carry in stock some spare gears and discs, and with any little parts of that kind any superintendent can repair a meter if that is all that is needed; but if meters are frozen and the flanges are sprung, the easiest way is to box up a dozen of them and send them to the factory for overhauling. Minor repairs can be attended to generally in your own plant very readily. We manage to repair about 40 per cent of our damaged meters in that way. We have had forty odd repaired at the factory in the last two months. The average cost of repairs taken altogether runs less than $2.50 to $3.50 each, and for the service that the meters have done we can afford to put that money into it.

MR. W. J. WILLS: For minor repairs it would seem that the best thing is to have them attended to in your own repair shop, then ship back to the factory those needing general over-hauling.

MR. W. S. CRAMER: Any man capable of reading and inspecting meters should be able to make all ordinary repairs to meters, but would not advise the installation of machinery or the employment of skilled labor other than that necessary to care for meters in operation. We have nothing except a drill press and a good bench outfit, with all necessary taps and dies and in ten years we have found it necessary to send but six meters to the factory for repairs and of this number two had been frozen.

All our meters are tested on receipt from factory and all meters are tested whenever taken out if they are in but a month or less.

We find that the time of our meter readers is nicely divided between reading, repairing and testing, and with time left in which to do daily reading of large meters and weekly reading of commercial meters, and inspections.

MR. GEORGE HOUSTON: It is quite interesting to note the difference of opinion on this subject among good, honest, intelligent people in different parts of the country. We have in the neighborhood of 7000 meters. Two men do all the repairing, taking out the meters, cleaning, testing and again replacing them in position. One of these men gets a salary of $100 a month, the other $70 a month. Three years ago this last winter we had in the neighborhood of 450 meters frozen, some of them of course being badly damaged. Two years ago we had in the neighborhood of 300; last winter we had 350 or upward. Of those frozen meters we sent back 3 to the factory; and of all the disc chambers that were damaged there were but 21 that we had to send back to the factory for repairs. Now we test and put back on an average about 150 meters a month at the cost equal to the salaries of these two men who do all the repairing and cleaning, and also all shutting off and turning on of water, and look after delinquent collections. Any man who is any kind of a mechanic at all can in a short time repair almost any meter and put it in working order.

Inasmuch as we have an accurate testing machine we know what our meters are doing. We never test a meter for accuracy on less than a one-sixteenth-inch stream; usually we use a three-eighths-inch stream. Have not taken the pains to figure up what our saving has been, from what it would have cost us had we sent all these meters back to the factory. You can make the calculation for yourself. There are freight charges and cartage, and sometimes if you send a meter away the cost of express charges both ways will exceed the cost of material and time in making repairs. Besides, at this season of the year (the winter season) the factories are crowded with meters returned from other sections, and you will probably not get your meter back for two or three months. That necessitates putting in another meter making more office work which all adds to the expense of running the department.

Question No. 17: What is the responsibility of a water company or department for damages caused by bursting water mains?

MR. H. P. BOHMANN: Where no negligence can be proven the city is not liable as held by our City Attorney and sustained by the court.

MR. WILLIAM R. YOUNG: A short time ago in Lake City, Minnesota, a question came up as to the damage, and our local attorneys of Minneapolis decided for us on a question where water mains were on streets that had been vacated, that the main should be removed, or otherwise the city would be held for any damages that might occur on account of the break of such mains.

On the strength of our attorney's recommendation and the cases cited, the water mains were all ordered cut off under those buildings at quite an expense to the manufacturers, and new mains are now being constructed.

MR. W. H. RANDALL: Did we understand the last speaker to say that the mains were laid under the building?

MR. WILLIAM R. YOUNG: No, the streets were vacated after the mains had been laid, and the main alluded to remained there. The streets were vacated and turned into railroad property.

MR. W. H. RANDALL: We have had in Toronto two very serious breaks during the last winter in a thirty-six-inch main. Our Solicitor in Toronto was asked as to the liability of the city, the mains being laid on city property and on a city street. Two thirty-six-inch mains broke inside of probably three weeks' time. One split the whole length of the pipe; in the other the whole side of the pipe was practically blown out. Our Solicitor when interviewed by the gentlemen of the press, stated to them that the city had no responsibility, that it was an act of Providence, something that could not have been foreseen, and the city did not accept any liability as far as it was concerned.

MR. JOHN M. DIVEN: It is the law of the State of New York that property damaged must show negligence on the part of the water department to make them liable.

Question No. 18: It is a well known fact that when a thaw begins, and the frost goes out at the surface of the ground, there is increased trouble from frozen underground pipes; can any one explain or give the cause of this trouble?

MR. MORRIS R. SHERRERD: The cause of the apparent increase in the depth to which the frost goes in time of thaw is what in physics is called "The latent heat of fusion." Heat is taken up from the water pipe and ground, when the thaw takes place. This gives the effect of sending the frost deeper for the time of thaw.

MR. P. GEAR: We have had experience with frozen pipes on fine warm days which followed a period of cold nights and days and attribute it to the fact that people who have no meter on their services, allow their water to run during the cold weather so it will not freeze. When the warm day comes they shut their faucets off and the result is a frozen pipe. If you take a piece of iron, heat one end of it and put the heated end in cold water, the heat will be driven back to the end you hold in your hand. In the same manner probably the heat developed on a warm day drives the frost down enough to cause a freeze.